

THE AGE OF THE FOSSILS FROM BAARD'S QUARRY, LANGEBAANWEG, SOUTH AFRICA

By

Q. B. HENDEY

South African Museum, Cape Town

(With 3 figures and 5 tables)

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ABSTRACT

Fossils from the mined-out Baard's Quarry at Langebaanweg came from at least two stratigraphic horizons, those from the older horizon comprising the main body of fossils from the site. A re-evaluation of available Baard's Quarry material strongly suggests that, contrary to earlier opinions, it postdates the fossils from the near-by Varswater Formation in 'E' Quarry. The older, and predominant element in the assemblage is apparently late Pliocene or early Pleistocene in age and includes late surviving archaic species and endemic species in association with more advanced and more widespread taxa.

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INTRODUCTION

Fossils from phosphatic deposits in the vicinity of Langebaanweg, Cape Province, were first reported by Singer & Hooijer (1958). The specimen described by these authors came from Baard's Quarry, which was mined-out and back-filled some years later. Most of the fossils collected in the Langebaanweg area between 1958 and 1964 came from Baard's Quarry, other occurrences (see Hendey 1970a: 84-86, 96-98, 1974: 37) having been relatively unimportant and not relevant to the present study. After 1964 both mining and fossil collecting was continued in 'E' Quarry (the New Varswater Mine), which is situated about 2 km west of Baard's Quarry (Hendey 1970a, fig. 2). The 'E' Quarry fossil assemblage is vastly superior to that from Baard's Quarry in all respects and the latter has received little attention in recent years (see Hendey 1974, 1976).

One of the results of the shift in collecting from Baard's Quarry (and less

significant occurrences) to 'E' Quarry is that earlier reports on fossils from Langebaanweg dealt largely with Baard's Quarry, while later ones have dealt largely with 'E' Quarry. If, as some believe, the fossils from these two occurrences are contemporaneous and represent a single fauna, the provenance of specimens is relatively unimportant and references to 'the Langebaanweg fauna' are justified. This attitude has been most firmly supported by Wolff *et al.* (1973: 212) who stated that, 'It would be dangerous to infer a major difference in time of deposition' of the Baard's and 'E' Quarry fossils.

An alternative view expressed earlier (Hendey 1970a, 1972) and which was later maintained (Hendey 1974) is that the Baard's Quarry fauna includes some material of Pleistocene age (i.e. younger than ~ 2 million years) and some which is contemporary with the Pliocene 'E' Quarry (or Varswater Formation) fauna. More recently it has been indicated that all the Baard's Quarry fossils postdate those from 'E' Quarry (Hendey & Deacon 1977).

The purpose of the present paper is to review the available evidence on the age of the Baard's Quarry fossils. It is not intended to provide a final and definitive statement on these fossils. Some of the more significant specimens from this site are no longer in the collections of the South African Museum and could therefore not be examined. In addition, although all the most diagnostic of the available specimens were studied, the material warrants further sorting and preparation, while at least some of it merits further detailed study.

AGE OF THE FOSSILS FROM 'E' QUARRY

Before dealing with the fossils from Baard's Quarry, the dating of those from the Varswater Formation in 'E' Quarry is reviewed.

As with most fossil occurrences in the south-western Cape Province, only relative dating methods can be applied in the case of the fossils from 'E' Quarry, and this has been based largely on correlations with fossils and faunas from east Africa. In recent years it has become widely accepted that the 'E' Quarry fossils date back between 4 and 5 million years (m.y.).

These fossils occur in several different horizons within the Varswater Formation but, since it was believed that deposition of this formation had not been prolonged, the fossils of the different horizons were regarded as broadly contemporaneous. The three main units constituting the Varswater Formation are the Gravel, Quartzose Sand and Pelletal Phosphorite Members (Hendey 1976) and it is likely that intervals of time intervened between their deposition. There is at present no way of gauging the interval between deposition of the Gravel and Quartzose Sand Members, since the largely marine fauna of the former is poorly known and has little in common with the largely terrestrial fauna of the Quartzose Sand Member.

The situation in respect of those deposits overlying the Gravel Member is more promising and fossiliferous horizons within these deposits are potentially datable in relative terms. For many years the correlation of the Varswater

Formation with the east African sequence was based on certain species included in the fauna of the Quartzose Sand Member. An age for this member of between 4 and 4,5 m.y. was suggested by the elephant in its fauna (see Maglio 1973), while the higher limit (i.e. 4,5 m.y.) was suggested to be more appropriate by the *Nyanzachoerus* (Hendey 1973). This is still regarded as a reasonable age estimate, there being nothing in the Quartzose Sand Member fauna to contradict it.

The Pelletal Phosphorite Member is undoubtedly younger than the Quartzose Sand and there are indications that the interval between their deposition may have been appreciable, although an age of less than 4 m.y. for the Pelletal Phosphorite was considered unlikely (Hendey 1976: 244).

There are as yet no grounds for questioning the upper age limit of 5 m.y. for the Varswater Formation, but the 4 m.y. minimum date may be less secure. One of the most recently recognized complications in dating this formation stems from the fact that there are within the Pelletal Phosphorite Member two fossiliferous horizons which were perhaps separated by yet another interval of time. These two horizons, which were apparently river channel deposits, are informally termed bed 3aS and bed 3aN (Hendey 1976: 226–230). They have yielded large numbers of fossils, although relatively few have yet been studied and it is therefore premature to discuss their age. Nevertheless, it does seem advisable to regard the 3aS and 3aN faunas as separate units and to note the possibility that either the 3aN fauna or both may be less than 4 m.y. old.

In the discussions which follow references are made to the 'faunas' of 'E' Quarry. They are comprised of the assemblages from, in descending order of age, the Quartzose Sand Member and beds 3aS and 3aN of the Pelletal Phosphorite Member. Although there are doubts about their actual age, all are likely to date from the earlier half of the Pliocene.

GEOLOGY OF THE BAARD'S QUARRY AREA

There are striking differences between the deposits in the Baard's Quarry area and those constituting the Varswater Formation as it is exposed in 'E' Quarry, but since there are no records of the succession in the intervening area, unequivocal correlation of the two sequences has not been possible (Hendey 1970a; Wolff *et al.* 1973). The situation is complicated by the fact that whereas the 'E' Quarry deposits, of which there are still extensive exposures, are well known and have been studied in detail, the Baard's Quarry succession was inadequately recorded and is, by comparison, poorly known.

Brief accounts of the Baard's Quarry succession appeared in early reports on the Langebaanweg fossils (Singer & Hooijer 1958; Boné & Singer 1965), while there are some unpublished records available. In addition, Tankard (1975: 273, fig. 12) gave an account of deposits on the farm Muishondsfontein, which are a northerly extension of those which were exposed in Baard's Quarry. There clearly was variation in the nature and depth of individual units in the succession, but apparently the basic sequence was as follows:

4. Surface aeolian sands.
3. Ferricrete and other duricrusts in an unconsolidated sand matrix.
2. Deposits, some in river channels, comprised of phosphatic sandstone, quartz porphyry cobbles and other elements in a clayey sand matrix. This was the unit from which the Baard's Quarry phosphate was recovered.
1. Clays and clayey sands into which the channels of unit 2 are incised.

PROVENANCE OF THE BAARD'S QUARRY FOSSILS

Almost all the fossils from Baard's Quarry were collected after the deposits in which they occurred had been moved by the mining operation and consequently the provenance of specimens has for the most part to be inferred.

There are no definite records of fossils occurring in the surface sands (unit 4 of the succession), which are presumably of late Pleistocene/Holocene age. There are, however, a few unmineralized (sub-fossil) bones in the assemblage which probably came from this horizon. The material in question was excluded from the present study.

Some fragmentary fossils were recovered from unit 3 during excavations carried out in the Baard's Quarry area in 1965. No significant specimens are included in this material, but it is important since its very characteristic state of preservation is shared by some specimens in the original assemblage and it is presumed that they too were derived from unit 3. Significantly the only identifiable specimens in this part of the assemblage belong to species recorded elsewhere in the south-western Cape Province from middle to late Pleistocene occurrences (*vide infra*). The unit 3 fossils are evidently appreciably younger than most of the material from Baard's Quarry.

The economically exploited unit 2 was apparently the source of the majority of the Baard's Quarry fossils, including the first described fossil from this site (Singer & Hooijer 1958). This assemblage is comprised overwhelmingly of fragmented bones and teeth, many of which show signs of rolling and which are presumably from the unit 2 river channel deposits. These fossils may have been derived from pre-existing deposits, they may have been contemporaneous with the deposition of the unit 2 sediments, or both. The mineralizing agent in these specimens is phosphate, while the unit 3 fossils are ferruginized.

A few fragmentary fossils were recovered from unit 1 during the 1965 excavations, but it is unlikely that these deposits made a significant direct contribution to the original assemblage since the unit 1 deposits underlie the phosphatic horizon and consequently were not being mined. Nevertheless, part of the assemblage may have been from this horizon, while the unit 2 assemblage may include material derived from unit 1.

It is worth noting that the 1965 excavations were sited near the southern margin of Baard's Quarry, which had by then been back-filled, and that no phosphatic sandstone was encountered. No phosphatized fossils such as those which comprise the main body of Baard's Quarry fossils were recovered from

the 1965 excavations, and this is taken as a further indication that the original material came largely from unit 2 rather than unit 1.

There are a few specimens in the original assemblage which are in an unusual state of preservation and which in appearance resemble neither the ferruginized unit 3 specimens nor the phosphatized unit 2 specimens. This material includes part of a series numbered SAM-PQ-L179, which were evidently found together. In this instance, at least, adherent matrix, which has a clayey component, suggests derivation from the lower levels in the succession.

To sum up, the majority of specimens are here regarded as what is informally termed the 'lower levels' assemblage, that is, specimens from unit 2, but possibly from both 1 and 2, while a small number belong to the 'upper level' assemblage from unit 3.

THE 'UPPER LEVEL' ASSEMBLAGE

Only a few isolated teeth and tooth fragments belonging to the 'upper level' assemblage will be dealt with here, other available specimens being largely undiagnostic bone fragments.

Equidae

There are three teeth (L2095, L2106, L866) and three tooth fragments (L2111, L1527C and an unnumbered piece) belonging to *Equus* in the 'upper level' assemblage. *Hipparion* is not represented. The specimens L2106 and L2111, both M³'s, are here regarded as particularly significant since they can be compared with three fragmentary M³'s of *Equus* from the 'lower levels' assemblage (L2109, L1465E, L2129). Other Beard's Quarry *Equus* teeth are no longer in the South African Museum and could not be examined.

It must be stressed that Hooijer (1976a: 33-34, pl. 8) has already dealt with the specimens enumerated above. He found them unremarkable and all were provisionally assigned to *Equus capensis*.

There is only one character, the size of the postfossette, which can be observed in all five M³'s comprising the two sets of specimens. The postfossettes of the 'upper level' specimens are of comparable size and larger than those of the 'lower levels' specimens (Table 1). Otherwise comparisons must be confined to L2106 and L2109, which are the two most complete specimens. The former,

TABLE 1
Dimensions of *Equus* third upper molars from Beard's Quarry, Langebaanweg

	'upper level'		'lower levels'		
	L2106	L2111	L2109	L1405	L2129
Ant.-post. diam. at occlusal surface . . .	c. 39,0	—	—	—	—
Transv. diam. at occlusal surface . . .	c. 31,0	—	c. 29,0	—	—
Trans. diam. 20 mm from base of crown .	28,5	—	26,5	—	—
Ant.-post. diam. of protocone 20 mm from base	16,5	—	13,0	—	—
Mesostyle-metastyle length 20 mm from base	22,5	—	18,0	—	—
Max. ant.-post. diam. of postfossette . .	17,6	16,1	13,0	c. 12,8	15,0

which is from the 'upper level', is larger than L2109 in all other dimensions as well.

Morphologically L2106 and L2109 differ most strikingly in the degree of development of the metastyle/hypostyle. In L2106 this region of the tooth is particularly well developed, forming the most posterior margin of the tooth and being separated from the hypocone by a deeply indented and narrow hypoglyph. In L2109 the metastyle/hypostyle is less prominent and it is the hypocone which forms the posterior margin of the tooth, while the hypoglyph is shallower and more wide open than in corresponding parts of L2106. There are some differences in the enamel patterns of the occlusal surfaces of the teeth, but they are not recorded because equid teeth are notoriously variable in this respect.

In the past significance has been attached to minor differences in South African fossil *Equus* teeth and this contributed to the chaotic state of the group's nomenclature. It would therefore seem inadvisable to make much of the differences observed in the two sets of *Equus* teeth from Baard's Quarry, especially since the specimens involved are fragmentary and few. On the other hand, since these two sets of specimens are from different levels in the succession, the observable differences could be of evolutionary significance.

It now appears likely that in addition to the living zebras and their ancestors there was one lineage of large *Equus* present in Africa for much, if not all, of the Pleistocene. If this was indeed the case then it is likely that there were some changes in, for example, size and tooth characters in successive members of this lineage. Indeed, the middle Pleistocene large *Equus* from Elandsfontein near Langebaanweg does differ in certain respects from the late Pleistocene ('classic') *E. capensis* from other occurrences in the south-western Cape, the most obvious difference being the larger size of the latter.

The South African Museum's collections include many M³'s belonging to the large middle Pleistocene *Equus*, and in respect of both size and morphology the 'lower levels' L2109 is generally similar to them, whereas L2106 is larger and, in respect of the metastyle/hypostyle-hypoglyph-hypocone development, morphologically distinct. Unfortunately there were no M³'s available of large *Equus* of undoubted late Pleistocene age, but the 'upper level' M² (L2095) and lower molar (L866) are comparable in size to corresponding late Pleistocene teeth and larger than ones of middle Pleistocene age.

Inadequate though the evidence may be, it is tentatively concluded that the 'upper level' *Equus* is close to or identical with late Pleistocene *E. capensis* from the south-western Cape, whereas the 'lower levels' *Equus* is probably closer to but not identical with the middle Pleistocene *E. cf. capensis* from this region. The material is identified accordingly in Table 4.

Bovidae

The Baard's Quarry Bovidae will be dealt with in more detail by A. W. Gentry (in prep.), but he has kindly given permission for observations on them to be included in this paper.

A series of specimens numbered L21 include two left and two right upper molars and a lower molar of a reduncine. These teeth are closely matched by specimens belonging to the late Pleistocene *Redunca* cf. *arundinum* from Swartklip near Cape Town.

The teeth L1491A, D, F and J appear to belong to *Hippotragus gigas*, a species known from the early Pleistocene of east Africa, but which survived later in South Africa, being included in the middle Pleistocene fauna from Elandsfontein and possibly in the late Pleistocene fauna from Florisbad in the Orange Free State. The teeth of the living gemsbok, *Oryx gazella*, resemble those of *H. gigas* and there is a possibility that the Baard's Quarry specimens belong to a gemsbok.

The teeth L2110 and L2129B belong to the recently extinct blue antelope, *Hippotragus leucophaeus*, a species which is known only from the middle to late Pleistocene and Holocene of the south-western and southern Cape Province (Klein 1974a).

Two incomplete horn-cores (L1523, L1643A) and two unnumbered mandible fragments belong to *Raphicerus*. The teeth resemble those of the *Raphicerus* from the late Pleistocene Swartklip fauna, they are smaller than those of the middle Pleistocene *Raphicerus* from Elandsfontein and much smaller than the teeth of the 'E' Quarry *Raphicerus*. The horn-cores are correspondingly small.

The 'upper level' assemblage includes several alcelaphine teeth (L1491B, C and H, and possibly L1292), which represent at least two species. Although not identified, these specimens are more advanced than the 'E' Quarry alcelaphines and are likely to be Pleistocene in age.

Age of the 'upper level' assemblage

The 'upper level' fauna is clearly of Pleistocene age and indications are that it dates from the latter part of this epoch.

THE 'LOWER LEVELS' ASSEMBLAGE

Although a large amount of material is included in the 'lower levels' assemblage, the number of identifiable specimens is limited.

Tubulidentata

A single metacarpal IV (L908) is assigned to this order. The specimen is larger in most respects than the corresponding bones in the available series of four modern *Orycteropus afer*. It is particularly distinctive in its overall length (c. 53,5 mm), which contrasts with the range of 39,9 to 46,4 mm in the comparative series.

No aardvark metacarpals are represented in the 'E' Quarry assemblages, but there are at least six other postcranial bones and an isolated tooth, all of which fall within the size range observed in the four *O. afer* specimens. Indications are therefore that the Baard's Quarry aardvark was larger than that from 'E' Quarry

and was either not conspecific or represented a different variety of the same species. In either case it is unlikely that the two animals were contemporaneous.

Carnivora

A specimen tentatively identified as a jackal (?*Canis* sp.) (L1478) is included in the 'lower levels' assemblage and has already been described (Hendey 1974: 195). This animal is not conspecific and probably not even congeneric with the only canid recorded from 'E' Quarry, which is an as yet undescribed species of *Vulpes* (Hendey 1976).

A fragmentary upper canine (L1479) may belong to a lion-sized felid. Although the identification is uncertain, the animal concerned is not conspecific with any of the 'E' Quarry carnivores.

If the above specimens do indeed belong to a jackal and lion, this would indicate that they postdate the 'E' Quarry faunas, since these animals are known in Africa only from late Pliocene or post-Pliocene contexts.

Three carnivores are included in the L179 series of specimens which in respect of their preservation differ from most other specimens in the 'lower levels' assemblage (see p. 5). Two have already been described (Hendey 1974: 242, 279). They were identified as *Mellivora* cf. *capensis* (L179/12) and *Hyaena* cf. *bellax* (L179/11). Although these identifications are tentative, the species concerned are not conspecific with any from 'E' Quarry and the *Mellivora* at least is clearly more advanced than its 'E' Quarry counterpart. Both species suggest a Pleistocene date. The third carnivore is represented by a mandible fragment (L179/13) which may belong to a canid.

The only other potentially useful 'lower levels' carnivore specimens are two proximal radius fragments (L1400, L1706) belonging to a pinniped. They are similar to the radii of the 'E' Quarry *Prionodelphis capensis*, but positive identification of such fragmentary specimens was not possible.

Proboscidea

The best proboscidean specimens from Baard's Quarry were not available during the present study. This is unfortunate in view of the importance attached to proboscideans in faunal dating and the confusion which now exists in respect of the species represented in the Baard's Quarry assemblage.

The first fossil from the Langebaanweg area to be described was a fragmentary elephant molar, which is one of the specimens no longer in the South African Museum. It was originally referred to *Stegolophodon* (Singer & Hooijer 1958), but subsequently identified as *Mammuthus subplanifrons* (Maglio & Hendey 1970; Maglio 1973). The revised identification was ignored by Wolff *et al.* (1973: 209) who claimed that three species of 'elephant' are present at 'the site', the 'site' including both Baard's and 'E' Quarries. In their table 1 they listed *Stegolophodon*, presumably meaning the material identified elsewhere as *M. subplanifrons*, *Archidiskodon*, which is in part a junior synonym of *Mammuthus* (Maglio 1973), *Stegodon*, which is now generally assigned to the Stegodontidae rather than the Elephantidae, and *Anancus*, which is a gomphothere.

The issues which have therefore to be settled are the identity of the proboscideans from the Langebaanweg sites and the source of the material. Since the observations which follow are confined to material in the South African Museum and since this material now requires further detailed study by an authority on proboscideans, a final statement is not possible.

Parts of a *Mammuthus subplanifrons* individual from the Quartzose Sand Member are the only described proboscidean material from 'E' Quarry (Maglio & Hendey 1970; Maglio 1973), although many additional specimens, mainly isolated teeth, apparently belonging to this species are now available. The undescribed specimens are from bed 3aN of the Pelletal Phosphorite Member and are therefore somewhat younger than the described material. An unidentified anancine gomphothere is also known from 'E' Quarry. It is represented by many isolated teeth from the Pelletal Phosphorite Member.

The Baard's Quarry proboscidean specimens in the South African Museum are all from the 'lower levels' assemblage. The material, which is very fragmentary, apparently belongs to only two species. As in the case of 'E' Quarry, one is identified with the elephant, *M. subplanifrons*, while the other is an unidentified anancine gomphothere. Other taxa may be represented amongst the material now housed elsewhere.

Nothing constructive emerged from the comparison between the Baard's and 'E' Quarry *M. subplanifrons* specimens. None of the Baard's Quarry tooth fragments is exactly matched by corresponding parts of the more complete 'E' Quarry specimens, but, since the latter exhibit appreciable variation, no significance could be attached to the differences observed.

Although *M. subplanifrons* is represented at both sites it does not necessarily follow that the animals concerned were contemporaries, since there are indications that the species had a long history in South Africa (see p. 20).

The only Baard's Quarry gomphothere specimen is an incomplete cheek-tooth, apparently a left M_2 (L1179) of which parts of three cone-pairs and the talonid are preserved. Although gomphothere M_2 's from 'E' Quarry vary both in size and morphology, L1179 is distinct in having the preserved lingual cones transversely elongated and plate-like compared with the conical structures of the 'E' Quarry specimens (Fig. 1). This characteristic is also not evident in east African anancine gomphotheres, which survived until about 4 m.y. ago (Maglio 1974; Beden 1976), and it is regarded as an evolutionary advance which indicates that the Baard's Quarry gomphothere is younger than those from east Africa and 'E' Quarry. Although not directly relevant, it is worth noting that *Anancus* survived into the Pleistocene in Europe (Kurtén 1968).

The Baard's and 'E' Quarry proboscidean assemblages thus have an elephant species in common and each has a gomphothere, with the species from Baard's Quarry being the more advanced. In view of the differences between the gomphotheres and the possibility that *M. subplanifrons* had a long history in South Africa, there is no sound basis for concluding contemporaneity between the two faunas on the basis of the proboscideans represented.

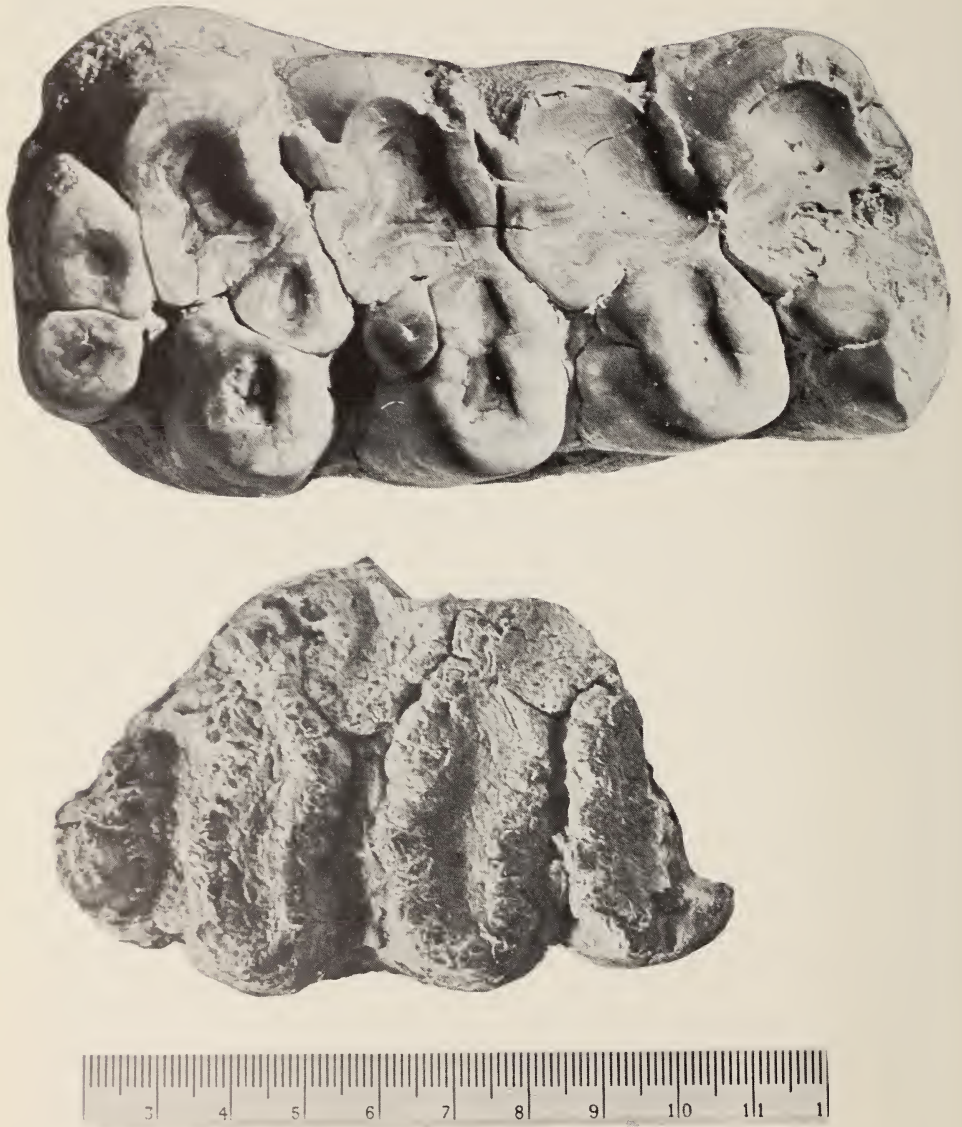


Fig. 1. Occlusal views of gomphothere M_2 fragment from Beard's Quarry (L1179) (below) and gomphothere M_2 from 'E' Quarry (L41018) (above). Specimens are in a similar state of wear. Scale in millimetres.

Rhinocerotidae

Rhinoceros tooth fragments are probably the most commonly represented identifiable element in the 'lower levels' assemblage. Hooijer (1976a) has recorded the presence of *Diceros bicornis* in this assemblage and most of the available specimens apparently belong to this species. A few fragments are, however, too high-crowned for *Diceros* and probably represent a *Ceratotherium*.

D. bicornis is not known in Africa from occurrences older than 4 m.y., whereas the 'E' Quarry rhinoceros, *Ceratotherium praecox*, is known only from 4 to 7 m.y.-old contexts (Hooijer 1976a). The *Diceros* therefore suggests that the 'lower levels' assemblage postdates that from 'E' Quarry. The 'lower levels' *Ceratotherium* is of little significance because it could as well represent the post-4 m.y. *C. simum* as the pre-4 m.y. *C. praecox*.

Equidae

Both *Equus* and *Hipparion* are represented in the 'lower levels' fauna. The former was dealt with earlier (p. 5) and all that need be added here is that the presence of *Equus* is one of the firmest indications that the 'lower levels' fauna postdates that from 'E' Quarry. *Equus* is apparently not known anywhere in Africa from occurrences older than about 2 m.y. (Hooijer 1976b; Eisenmann 1976), although it was present in Europe about 3 m.y. ago (Kurtén 1968). Indications are therefore that the first appearance of *Equus* in Africa cannot predate 2 to 3 m.y.

There are several issues relating to *Hipparion* from the Langebaanweg sites which have yet to be resolved (Hendey 1976; Hooijer 1976a), but the only one to be dealt with here is whether or not the 'E' and Baard's Quarry *Hipparion* assemblages are likely to be contemporaneous.

The present study was confined to the lower cheekteeth from the two sites. The study was commenced with these specimens and since they alone indicate that at least two distinct (i.e. non-contemporaneous) populations are represented, other available material was not examined. Material representing two individuals from 'E' Quarry are excluded from the results of the study presented here. The premolar row L25197 was excluded because it is clearly atypical of the Langebaanweg assemblage as a whole and is the only material tentatively assigned to *H. namaquense* by Hooijer (1976a: 26). The Quartzose Sand Member dentition L13102 was excluded because the immaturity of the individual concerned made the teeth appear to differ in size from their Baard's Quarry counterparts to a far greater extent than other teeth from 'E' Quarry. The comparison was thus confined to specimens of roughly comparable ontogenetic age.

The lower cheekteeth from Baard's Quarry differ most obviously from the 'E' Quarry specimens in the following respects:

1. The Baard's Quarry teeth have more pointed metaconids and metastylids, which results in their having more prominent vertical ribs on their lingual surfaces.
2. The Baard's Quarry teeth are in general larger than those from 'E' Quarry.

They also seem to have more wrinkled enamel, at least on their buccal surfaces, and a heavier covering of cement, but no attempt was made to establish these and other possible differences conclusively, the two listed above being considered sufficient for the purposes of the present study.

Hooijer (1974: 30) has indicated that the development of 'pointed rather than rounded loops' in the metaconid and metastylid is 'a progressive feature' in *Hipparion*. For example, in Miocene *H. primigenium* the loops are rounded, whereas in Pleistocene *H. ethiopicum* they are pointed (Hooijer 1975). In this respect the Baard's Quarry teeth are clearly more advanced than those from 'E' Quarry, in which the metaconid is almost invariably rounded and the metastylid is occasionally rounded (Fig. 2).

Hooijer (1975) has commented on the difficulties which can be experienced in obtaining measurements of *Hipparion* teeth which can be meaningfully compared irrespective of the ontogenetic age of the individuals concerned. His methods, with one modification, are followed. The breadth measurements given here are of tooth enamel and not of the enamel plus cement. Measurements given elsewhere may or may not include the cement, this being dependent on the condition and/or ontogenetic age of individual specimens. There were a few instances in the present study where breadth measurements might be fractionally higher because of a thin cement covering, but in no instances were dimensions affected significantly.

Only in the case of the P₂'s were the Baard's and 'E' Quarry assemblages not clearly distinct from one another in terms of size (Tables 2, 3). This may in

TABLE 2
Dimensions of the Baard's Quarry *Hipparion* lower cheekteeth

	P ₂		P ₃ /P ₄		M ₁ /M ₂		M ₃	
	l	b	l	b	l	b	l	b
L1592/L1446B	c. 29,0	13,5	—	—	26,8	13,0	—	—
L947	33,9	14,2	—	—	—	—	—	—
L944/L951	—	—	27,6	16,0	25,9	14,0	—	—
L946	—	—	27,0	16,1	—	—	—	—
L1465B	—	—	28,2	15,5	—	—	—	—
L1451A	—	—	28,2	16,3	—	—	—	—
L943	—	—	27,5	16,8	—	—	—	—
L1447A	—	—	c. 28,5	c. 16,5	—	—	—	—
L957	—	—	—	—	29,4	15,9	—	—
L954	—	—	—	—	28,6	16,1	—	—
L959*	—	—	—	—	25,3	14,4	—	—
L952	—	—	—	—	25,9	15,1	—	—
L1448	—	—	—	—	25,5	15,1	—	—
L1447B	—	—	—	—	26,6	15,9	—	—
L1635A	—	—	—	—	27,9	16,1	—	—
L1465P	—	—	—	—	24,6	13,5	—	—
L1455C	—	—	—	—	—	—	32,0	12,2
L252	—	—	—	—	—	—	31,6	12,7
L938	—	—	—	—	—	—	32,5	c. 12,0

* See Figure 2.



Fig. 2. Occlusal and lateral views of *Hipparion* molars from Beard's Quarry (L959) (right) and 'E' Quarry (L41747) (left). The specimens are close to the mean sizes for $M_{1,2}$ of the two samples and are in a similar state of wear. Scale in millimetres.

TABLE 3
Dimensions of the 'E' Quarry *Hipparion* lower cheekteeth

	P ₂		P ₃		P ₄		M ₁		M ₂		M ₃	
	l	b	l	b	l	b	l	b	l	b	l	b
L10954	28,6	12,5	26,5	13,0	25,5	12,7	22,4	12,0	21,8	10,9	—	—
L20541	26,6	12,6	25,0	13,8	22,8	13,6	—	—	—	—	—	—
L2546	—	—	25,5	13,7	23,4	13,5	21,1	11,3	—	—	—	—
L13104	—	—	27,9	13,0	26,1	13,2	—	—	—	—	—	—
L22674	—	—	—	—	c. 22,9	c. 12,5	c. 21,5	c. 11,5	—	—	—	—
L20553	—	—	—	—	—	—	20,9	12,3	23,0	12,0	28,3	11,3

	P ₂		P ₃ /P ₄		M ₁ /M ₂		M ₃	
	l	b	l	b	l	b	l	b
L40619	26,4	13,0	—	—	22,7	13,0	—	—
L46140/1	29,5	12,5	—	—	23,0	11,0	—	—
L12865/L13423	—	—	26,3	c. 12,5	24,5	11,5	—	—
L20259X	32,2	14,4	—	—	—	—	—	—
L3140	—	—	25,0	13,3	—	—	—	—
L41747*	—	—	—	—	22,1	12,7	—	—
L45411	—	—	—	—	22,6	11,7	—	—
L46139	—	—	—	—	23,9	13,3	—	—
L24610	—	—	—	—	24,2	13,5	—	—
L22547	—	—	—	—	23,5	12,5	—	—
L2545	—	—	—	—	—	—	26,5	10,8
L20907	—	—	—	—	—	—	28,6	10,0

* See Figure 2.

part, or wholly, be due to the fact that in equids the P₂ is one of the least useful teeth for distinguishing species (Cooke 1950). There are very clear size differences between the other lower cheekteeth (Figs 2–3), the Baard's Quarry teeth being the larger. Some overlap in size might have been observed had the two assemblages been larger, but the general size difference is indisputable.

The size difference coupled with an advance in tooth morphology indicates that two non-contemporaneous populations of *Hipparion* are represented and that the one represented at Baard's Quarry is the younger.

The taxonomic implications of this conclusion were not pursued and the arrangement of Hooijer (1976a), whereby the Baard's Quarry material is identified as *H. baardi* and that from 'E' Quarry as *H. cf. baardi*, is followed.

Hippopotamidae

A few fragmentary *Hippopotamus* teeth are included in the 'lower levels' assemblage, but they are inadequate for specific identification and no conclusion about their age relative to the 'E' Quarry *Hippopotamus* is possible.

Giraffidae

Giraffids are poorly represented in the Baard's Quarry assemblage, but one useful specimen is a *Sivatherium* metatarsal of an immature individual (L637). This specimen resembles metatarsals of the 'E' Quarry *Sivatherium* in terms of overall length and is appreciably longer than a middle Pleistocene specimen from Elandsfontein (see Harris 1976). The implication is that the Baard's Quarry

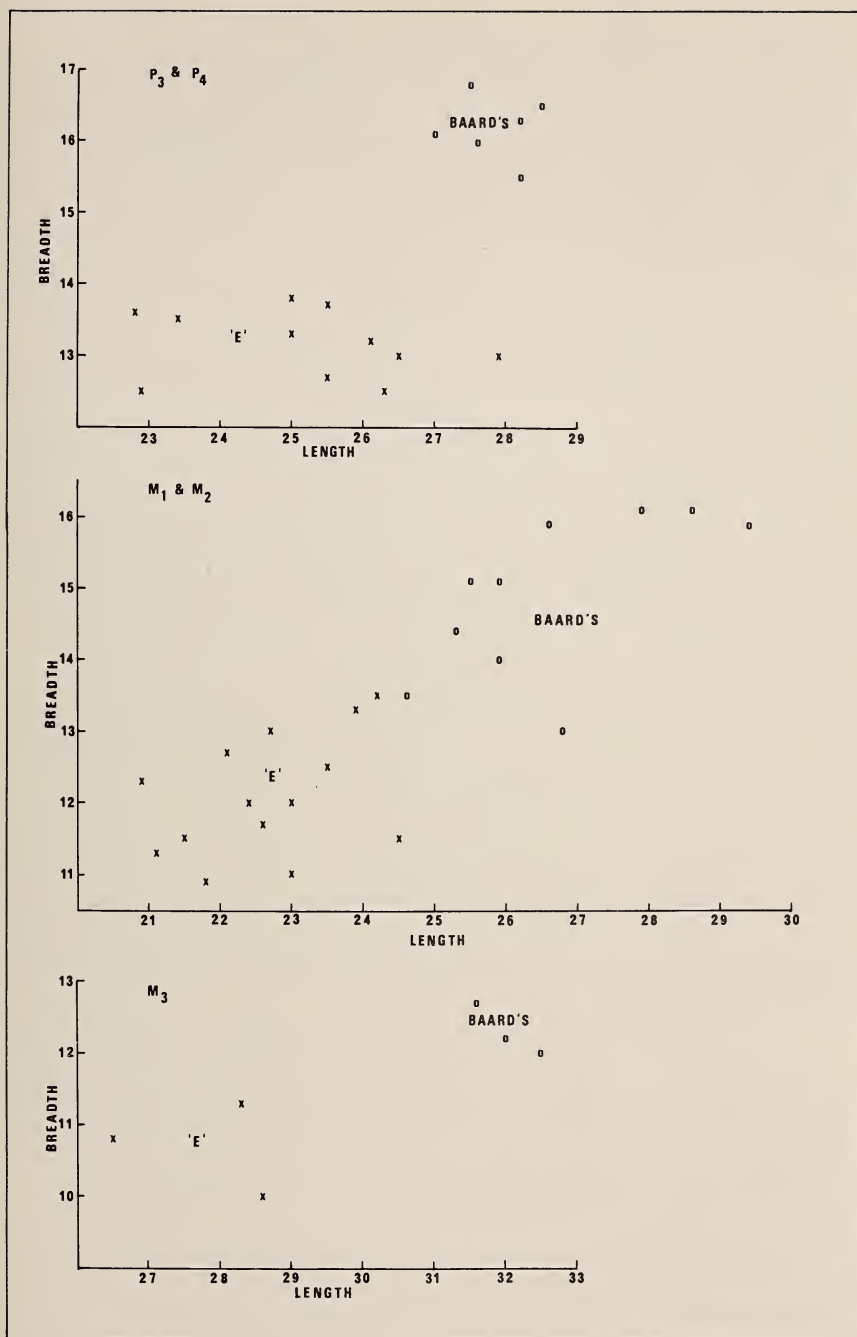


Fig. 3. Dimensions of lower cheekteeth of *Hipparion* from Baard's and 'E' Quarries.

Sivatherium was at a stage in evolution closer to a Pliocene representative of this genus than one of middle Pleistocene age.

It does not necessarily follow that the 'E' and Baard's Quarry sivatheres must have been contemporaries. It has already been suggested that elephants survived longer in a primitive state in South Africa during the Pliocene/early Pleistocene and presumably the same might have applied to other large herbivores such as sivatheres.

Bovidae

The 'lower levels' Bovidae will be dealt with in more detail by A. W. Gentry (in prep.), but some observations on them are included here.

At least seven species are represented, namely, a boselaphine, a reduncine, two alcelaphines, two antilopines and a neotragine.

A single horn-core fragment (L1588A) is similar in all observable respects with corresponding parts of *Mesembriportax acrae* horn-cores from 'E' Quarry and it is identified with this species (Gentry 1974). Although regarded as conspecific with the 'E' Quarry species, it is not necessarily contemporaneous. *M. acrae* is represented in 'E' Quarry by specimens from the Quartzose Sand Member as well as beds 3aS and 3aN of the Pelletal Phosphorite Member, so evidently the species was present in the area for what might have been an appreciable period.

Several incomplete horn-cores (e.g. L565, L1521) and a lower molar (L1487) belong to a reduncine which appears to have affinities with reduncines from east Africa and India that are older than 5 m.y. It is definitely not conspecific with either of the 'E' Quarry reduncines. This species is problematical since it is the only one from Baard's Quarry which suggests a late Miocene or early Pliocene age. Since it is apparently inconsistent with the 'lower levels' fauna as a whole, there must be some doubt about its relationships to the east African and Indian species. Certainly if the lower molar does belong with the horn-cores, the species cannot predate those from 'E' Quarry since the latter have more primitive teeth. The tooth, at least, is not inconsistent with the age of the 'lower levels' fauna inferred on other grounds.

A fragmentary horn-core (L9) and several fragmentary teeth (e.g. L2112, L1491E) belong to at least two alcelaphine species. The horn-core is a significant specimen because it resembles specimens from 'E' Quarry and might be related to the species to which they belong. Both the 'E' Quarry alcelaphines are primitive members of lineages apparently unrepresented elsewhere in Africa. One of them, 'species A', is commonly represented in both bed 3aS and bed 3aN and certain of the specimens from 3aN have features in common with L9. There is reason to believe that the 3aN 'species A' is a more advanced variety than that from 3aS and it is possible that L9 belongs to a still more advanced stage of the same lineage. If this is so, then the time interval between deposition of 3aN and the 'lower levels' at Baard's Quarry must have been far greater than that between deposition of 3aS and 3aN, because L9 is much more advanced than the 3aN

species A, whereas the latter is not appreciably different from the 3aS species A.

The 'lower levels' alcelaphine teeth represent at least two species which are distinguished on the basis of size. The smaller specimens may belong to the same species as L9. They correspond in size to alcelaphine teeth from 'E' Quarry, but are more hypsodont and in this respect at least are more advanced. The larger 'lower levels' alcelaphine is not conspecific with either of the 'E' Quarry species.

Several horn-cores (e.g. L1670, L1645) belong to a small but unidentified species of *Raphicerus*, which is not conspecific with the much larger 'E' Quarry *Raphicerus*. In terms of size at least these specimens correspond to those in the 'upper level' assemblage.

Five fragmentary horn-cores belong to a *Gazella*, which once again is not conspecific with its 'E' Quarry counterpart, but which appears most similar to the east African late Pliocene/early Pleistocene *G. praethomsoni*. Included in the L179 series, referred to earlier, are right and left horn-cores (L179/8, L179/10) and three lower molars (L179/4C, F, G) belonging to an *Antidorcas*, a genus which in east Africa is recorded as early as the late Pliocene, but which in South Africa is known only from post-Pliocene contexts.

In general, indications are that the 'lower levels' and 'E' Quarry bovid faunas were not contemporaneous and that the former is younger.

Age of the 'lower levels' fauna

The 'lower levels' and 'E' Quarry faunas have little in common and there are more differences than similarities between them (Table 4). The situation may be summed up as follows:

1. Six of the twenty-one 'lower levels' species are more advanced than their 'E' Quarry counterparts (*Mellivora*, gomphothere, *Hipparion*, one alcelaphine, *Raphicerus*, *Gazella*).
2. Six of the 'lower levels' species are not represented in 'E' Quarry and either definitely or probably suggest a younger date (?*Canis*, ?*Panthera*, *Hyaena*, *Equus*, *Diceros*, *Antidorcas*).
3. Three of the 'lower levels' species are either not conspecific with or sub-specifically distinct from their 'E' Quarry counterparts and suggest that the two faunas are not contemporaneous (*Orycteropus*, reduncine, one alcelaphine).
4. Four of the 'lower levels' species may or may not be conspecific with their 'E' Quarry counterparts (?*Prionodelphis*, *Ceratotherium*, *Hippopotamus*, *Sivatherium*).
5. Two of the 'lower levels' species are conspecific with species from 'E' Quarry (*Mesembriportax*, *Mammuthus*).

On balance the indications are that the 'lower levels' fauna postdates those from 'E' Quarry and that a late Pliocene or early Pleistocene age applies.

One possible complication with the 'lower levels' assemblage is that it may not represent a single fauna. This is unlikely because there are no instances apparent where individual taxa are represented by more than one evolutionary

TABLE 4

The mammalian faunas from Baard's Quarry, Langebaanweg, with a list of the nearest counterparts in the 'E' Quarry faunas

'E' QUARRY	BAARD'S QUARRY	
	'lower levels'	'upper level'
<i>Orycteropus</i> sp.	<i>Orycteropus</i> sp.	—
<i>Vulpes</i> sp.	? <i>Canis</i> sp.	—
<i>Mellivora</i> aff. <i>punjabiensis</i>	<i>Mellivora</i> cf. <i>capensis</i>	—
<i>Homotherium</i> sp.	? <i>Panthera</i> sp.	—
' <i>Percrocuta</i> ' <i>australis</i>	<i>Hyaena</i> cf. <i>bellax</i>	—
<i>Prionodelphis capensis</i>	? <i>Prionodelphis capensis</i>	—
<i>Mammuthus subplanifrons</i>	<i>Mammuthus subplanifrons</i>	—
Gomphotheriidae	Gomphotheriidae	—
<i>Ceratotherium praecox</i>	<i>Ceratotherium</i> sp.	—
—	<i>Diceros bicornis</i>	—
<i>Hipparion</i> cf. <i>baardi</i>	<i>Hipparion baardi</i>	—
—	<i>Equus</i> cf. <i>capensis</i>	<i>Equus capensis</i>
<i>Hippopotamus</i> sp.	<i>Hippopotamus</i> sp.	—
<i>Sivatherium hendeyi</i>	<i>Sivatherium</i> sp.	—
<i>Mesembriportax acrae</i>	<i>Mesembriportax acrae</i>	—
Reduncini (2 spp.)	Reduncini	Reduncini
—	—	<i>Hippotragus gigas</i> or <i>Oryx gazella</i>
—	—	<i>Hippotragus leucophaeus</i>
Alcelaphini (2 spp.)	Alcelaphini (2 spp.)	Alcelaphini (2 spp.)
<i>Gazella</i> cf. <i>vanhoepeni</i>	<i>Gazella</i> cf. <i>praethomsoni</i>	—
—	<i>Antidorcas</i> sp.	—
<i>Raphicerus</i> sp.	<i>Raphicerus</i> sp.	<i>Raphicerus</i> sp.

NOTE: unclassified or incompletely classified taxa listed in more than one column are not necessarily identical.

stage, while the combination of species is for the most part what might be expected in an African fauna of late Pliocene/early Pleistocene age. The fauna is, in fact, unusual in some respects when compared with Plio/Pleistocene faunas in east Africa, but its peculiarities can be explained by the existence in the far south of the continent of endemic species and/or late surviving primitive forms. This aspect of faunas in the south-western Cape Province will be dealt with again later (p. 20).

DISCUSSION

When the present study on the age of the Baard's Quarry fossils was commenced, there appeared to be only three possibilities which needed to be considered. They are:

1. The Baard's and 'E' Quarry fossils are contemporaneous (Wolff *et al.* 1973).
2. Part of the Baard's Quarry assemblage is contemporaneous with that from 'E' Quarry (i.e. Pliocene), but the rest is younger (i.e. Pleistocene) (Hendey 1970a, 1972, 1974).
3. All the Baard's Quarry fossils postdate those from 'E' Quarry (Hendey & Deacon 1977).

The existence of at least two faunal units in the Baard's Quarry assemblage, the younger of which is Pleistocene in age (i.e. the 'upper level' fauna), must now be beyond doubt. Since this fauna is limited in size and not problematical in respect of its age relative to the 'E' Quarry faunas, it can be excluded from further consideration and attention can be devoted to the main body of fossils from Baard's Quarry, namely, those constituting the 'lower levels' assemblage (Table 4).

The first of the three alternatives listed above, which was in fact not adequately substantiated when it was supported by Wolff *et al.* (1973), can now be dismissed. Wolff *et al.* (1973: 212) quoted faunal lists in Hendey (1969, 1970*a*, 1970*b*) and their own table 1 in concluding that, 'Virtually all the taxa listed for Baard's are known from "E" Quarry'. Their table 1 did not record the provenance of the species listed, while the faunal list in Hendey (1970*b*) referred only to species from 'E' Quarry and differed in only minor respects from that in Hendey (1970*a*). Consequently their conclusion must have been based on the lists in Hendey (1969, 1970*a*). Reference to these lists reveals only two species common to the 'E' and Baard's Quarry faunas, namely, '*Hipparion albertense baardi*' and '*Libytherium olduvaiense*', which had been included on the basis of publications by Boné & Singer (1965) and Singer & Boné (1960). The alleged similarities observed by Wolff *et al.* referred to taxa which were not identified, incompletely identified or tentatively identified, an exceedingly weak basis for correlation. Their conclusion could not have been based on a personal knowledge of all the material concerned, since none of them has seen the specimens collected at Langebaanweg since 1967, that is, the vast majority of specimens from 'E' Quarry.

The present study has shown that there are indeed two species common to the Baard's 'lower levels' and 'E' Quarry assemblages. Even if these two are combined with the four other taxa which might be conspecific, they still constitute only 29 per cent of the 'lower levels' fauna. A comparison between the thirty-one named species from Members B and G of the Shungura Formation in Ethiopia reveals that about 29 per cent are common to both and yet there is an age difference of about 1 m.y. between them (Coppens & Howell 1976).

If there are still adherents to the first alternative listed above, their case will have to be restated in the light of information now available.

The second and third alternatives can be considered together because the one is a modification of the other, the earlier view that the Baard's Quarry assemblage included Pliocene and Pleistocene elements being replaced by the opinion that the former is rather of late Pliocene/early Pleistocene age. The change in opinion came about largely because certain specimens and species previously included with the Pleistocene element had, because of their state of preservation, to belong with other specimens and species which were regarded as Pliocene in age. In other words, it was the combination of 'Pliocene' and 'Pleistocene' species to form what is now termed the 'lower levels' fauna which led to the conclusion that the early element in the Baard's Quarry assemblage must postdate the faunas from 'E' Quarry.

The combination of species in the 'lower levels' fauna is admittedly not paralleled by any other late Pliocene/early Pleistocene fauna recorded in Africa, but its peculiarities can be explained by the location of the site near the southern continental extremity in a distinct geographic region far from other contemporary or near contemporary occurrences. At least two, and possibly three, of the taxa, namely, *Hipparion baardi*, *Mesembriportax acrae* and possibly the L9 alcelaphine, belong to lineages not represented further north in Africa during the Pliocene and early Pleistocene. They are, or appear to be, southern endemics. The potential for endemic speciation amongst the larger herbivores of the south-western and southern Cape (i.e. Cape Biotic Region) has been suggested by the late Pleistocene bovids of this region (Hendey 1974: 14-19; Klein 1974b: 43).

While endemism in the Cape fauna may be due simply to the region's distinct climate and vegetation, the region does, in addition, have the potential to become zoogeographically isolated from the rest of the subcontinent through aridification of areas immediately adjacent to it (Hendey 1974). It is not known if the Cape Biotic Region existed in its present form during the Pliocene, but by this time the climatic stability of the Tertiary was giving way to the instability of the Quaternary. Consequently it may have been during the Pliocene that aridification on the subcontinent first resulted in isolation of the more southerly parts of South Africa. The free interchange of mammals between southern Africa and regions further north is likely to have been impeded not only by the Namib and Kalahari deserts and adjacent semi-arid areas in the south-west of the subcontinent, but also by large rivers such as the Zambezi and Limpopo which traverse the eastern parts of southern Africa (Maglio 1973: 34). Isolation, even if it is incomplete, increases the potential for the evolution of endemic species and may also allow certain taxa to survive longer than their counterparts elsewhere. The latter is believed to apply in the case of *Mammuthus subplanifrons*.

The situation in respect of South African *M. subplanifrons* is complicated and unsatisfactory. Maglio (1973: 53) found this taxon to be 'represented [by] a heterogeneous assemblage with primitive molars whose relationships can only be clarified by discovery of cranial material'. Furthermore, although Maglio (1973: fig. 15 and elsewhere) records no occurrence of *M. subplanifrons* younger than 4 m.y., the dating of South African material is insecure. For example, Maglio (1973) judged the 'primitive' Quartzose Sand Member *M. subplanifrons* to be between 4 and 4.5 m.y. old, but there is now at least a possibility that the younger, although apparently equally primitive, bed 3aN representative of this species may have been less than 4 m.y. old (*vide supra*). In addition, Maglio's suggestion that the 'progressive' *M. subplanifrons* from Virginia, Orange Free State, dates back at least 4 m.y. was surprising since this material was said to occur in association with artefacts (Meiring 1955). The supposed antiquity of the Virginia mammoth has made it unique in the Orange Free State, a province which has otherwise produced only middle Pleistocene or younger fossils from similar occurrences. Maglio's suggestions about its age were sufficiently striking to prompt a study of its geological associations by Butzer (1973). This study did

not contradict the Pliocene date, but there must be some doubt as to whether the geological and geomorphological observations actually confirm the date. Certainly Butzer's study did not confirm the presence of artefacts in the deposits, but even so the age of this specimen cannot be regarded as settled beyond doubt.

Maglio (1973) indicated a time range of only 0,5 m.y. for *M. subplanifrons*, but found that the range for *Loxodonta adaurora* in east Africa 'must be taken as at least two million years, with very little change in molar structure throughout this period' (p. 25). It now appears likely that his figure is an overestimate since *L. adaurora* does not occur later than Member B in the Shunguru Formation (Beden 1976), but a range of about 1,5 m.y. for the species still applies. Presumably a time range of this order might also have applied to South African *M. subplanifrons*, especially since there is no evidence of more advanced elephant species on the subcontinent during the late Pliocene and early Pleistocene. With the exception of problematical, but nevertheless primitive specimens from the Vaal River Gravels, the only other Plio/Pleistocene elephant recorded from South Africa is an *Elephas ekorensis* from Bolt's Farm, Transvaal, which Maglio (1973: 34) believes may indicate that 'an earlier stage of the (*E. ekorensis*) lineage persisted in southern Africa long after it was succeeded by a more progressive stage further north'. If this was indeed the case, then the late survival in South Africa of primitive *Mammuthus* is also likely.

The possible late survival of *E. ekorensis* in the Transvaal and *M. subplanifrons* in the Orange Free State suggests that the zoogeographic isolation referred to earlier may have encompassed more of South Africa than just the Cape Biotic Region as it is now defined (Hendey 1974).

In spite of the many uncertainties which exist there do appear to be grounds for believing that early elephant evolution in South Africa may not have paralleled the well-documented east African pattern. The presumption that all *M. subplanifrons* on the subcontinent must be at least 4 m.y. old seems less warranted than to presume that this heterogeneous taxon had a long local history. At the very least, the issue cannot be regarded as settled.

If *M. subplanifrons* did indeed survive longer in a primitive state in South Africa, the same might also have applied to other large herbivores such as *Sivatherium*. This would account for the fact that the Baard's Quarry *Sivatherium* resembles the Pliocene *S. hendeyi* rather than the Pleistocene *S. maurusium*, at least in terms of limb-bone proportions.

The implication is that during periods when the more southerly parts of South Africa were isolated the large herbivores showed little or no evolutionary change (i.e. they remained 'primitive'), whereas the smaller ones did evolve but, being isolated from their counterparts further north, represented locally endemic lineages. There is, however, an anomaly in this hypothesis since one of the large herbivores from Baard's Quarry, the gomphothere, apparently exhibits an evolutionary advance over its 'E' Quarry counterpart.

Mammals such as carnivores, which are less influenced by environmental factors and less likely to have their dispersal impeded by such factors, were not

necessarily affected by the isolation of parts of the subcontinent. Since in this case the isolating mechanism was aridification, isolation in respect of the mammalian fauna could never have been complete, with some faunal interchange likely and accelerating as conditions in the arid and semi-arid regions ameliorated.

Since faunal dating of the Langebaanweg sites is based on correlations with the east African record, this dating is likely to be complicated by the regional peculiarities of the local fauna. Consequently particular significance is attached to the first appearances of taxa in east Africa. The southerly part of South Africa is unlikely to have been a significant centre of mammalian evolution, and terrestrial species can otherwise only have moved into the area from points north. For example, if Maglio's (1973) interpretation and dating of the origin of the Elephantidae is correct, then the earliest record of *Mammuthus subplanifrons* in the Langebaanweg area (i.e. the 'E' Quarry Quartzose Sand Member specimen) cannot be older than 5 m.y. and is most likely to be in the 4-4.5 m.y. range as Maglio suggested. Similarly, if the Shungura Formation Member G record of

TABLE 5
Relative age of deposits in the vicinity of Langebaanweg

<i>Estimated age in millions of years</i>	'E' QUARRY	BAARD'S QUARRY
Less than 1 m.y.	SURFACE BED OCCURRENCES*	'UPPER LEVEL'
	(6) Interval greater than (5)	(5) Interval similar to (4)?
About 2 m.y.		'LOWER LEVELS'
		(4) Interval greater than (3)
About 4,5 m.y.	VARSWATER FORMATION	PELLETAL PHOSPHORITE MEMBER (3aN)
		(3) Interval less than (2)
		PELLETAL PHOSPHORITE MEMBER (3aS)
		(2) Interval of unknown duration
		QUARTZOSE SAND MEMBER
		(1) Interval of unknown duration
Not more than 5 m.y.	GRAVEL MEMBER	

* Several isolated occurrences, none of which is necessarily contemporaneous with the 'upper level' at Baard's Quarry.

Equus is the earliest for this taxon in Africa, then the Baard's Quarry 'lower levels' *Equus* cannot be older than about 2 m.y.

As more is learnt of the origin and evolution of African mammals, it should become possible to refine the faunal dating of the Langebaanweg assemblages. The present view on the relative ages of deposits in the vicinity of Langebaanweg is summarized in Table 5.

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